BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

[002] The present invention relates generally to the field of bicycles and more particularly to an improved bicycle pedal and crank assembly.

BACKGROUND ART

[003] A number of pedal and crank designs have been made commercially available. Pedal designs include basic pedals and a variety of clipless versions for clamping shoes to pedals. Something that all pedals have in common is that they employ a spindle that is fixedly mounted to the crank arm, a pedal body that rotates about the spindle, and bearings or bushings between the pedal body and the spindle. The pedal spindle is always rigidly connected to the crank arm, usually by threading the spindle directly into the crank arm. The pedal spindle never turns relative to the crank arm.

[004] Cranks typically have a threaded hole at the end of each crank arm for attaching the pedal spindle. Most cranks connect to a bottom bracket axle on the end of each arm opposite the pedal. The bottom bracket connects to the bottom bracket housing of the bicycle frame, and normally includes two or more bearings for the bottom bracket axle to turn. That way, the crank arms rotate smoothly relative to the bicycle frame. Some cranks have integrated the bottom bracket so that the bottom bracket axle is permanently connected to at least one of the crank arms. In some designs, this allows the bottom bracket axle to be made larger and the bearings to be moved outboard, stiffening the system, and/or reducing the system weight. In no cases is there a bearing incorporated into the pedal end of crank arms.

[005] In bicycling, weight is extremely important because the power that a human produces is relatively small. Even small savings in weight can be extremely beneficial to racers and people who cycle long distances.

[006] Pedals typically contain from 10 to 50 components. For example, a typical double side entry prior art clipless pedal, US patent number 5,203,229, has 39 components not including the cleat. Generally, clipless pedals contain more components than basic pedals because the mechanism for clamping onto a cleat usually adds parts. Generally, more components leads to higher costs and poorer performance in adverse environmental conditions.

[007] Pedals are often used in extreme conditions. This is especially true because pedals are low to the ground and interface with the rider's shoe. Pedals are exposed to dirt, rain, mud, snow, and varying temperatures. Because of these factors, sealing the bearings and bushings from contamination is extremely important. Currently, because the seals are located on the pedal, they are in direct contact with the rider's shoes, which are often contaminated with dirt, mud, sand, etc.

[008] For many pedals on the market, rebuilding the bearings and bushings is difficult or impossible for most consumers. Oftentimes, it is very difficult to access the bearings or bushing, and once accessed, it is often difficult to remove them. For pedals that use loose ball bearings rather than cartridge bearings or bushings, it is easy to lose the balls during disassembly, and nearly impossible to reassemble the balls and properly adjust the bearings. Most pedals that use loose ball bearings are realistically disposable rather than rebuildable.

[009] Stack height is the distance between the bottom of the rider's shoe and the centerline of the spindles of their pedals. In order to lower the rider's center of gravity for better stability, it is preferable to have the lowest stack height possible. Currently, all pedals have at minimum a spindle, some form of bearings, and a body. The stack height is determined by adding these layers. U.S. Patent No. 4,080,017 discloses one way to reduce stack height in a bicycle pedal, but at the expense of increasing Q-factor.

[010] Q-factor is the distance between the center of the pedal body to the centerline of the bicycle. Essentially, Q-factor is a measure of how far the rider's feet are apart from each other. Q-factor is determined by a combination of the bottom bracket spindle length, the crank offset, and length of the pedal. Many bicyclists have a strong preference for the Q-factor depending on their leg length and their particular physiology. Most commonly, bicyclists can suffer from knee pain and damage if the Q-factor is too large.

SUMMARY OF THE INVENTION

[011] The present invention provides a pedal for bikes, which has a shaft that is fixed in relation to the pedal body instead of a spindle that rotates in relation to the pedal body.

[012] The present invention provides a pedal for bikes, which has no bearings or bushings for pedal body rotation.

[013] The present invention provides a crank for bikes, which has a bearing or bushing for receiving a pedal shaft.

[014] The present invention provides a pedal for bikes, which has fewer components than conventional bicycle pedals.

[015] The present invention provides a pedal for bikes, which has improved contamination protection.

[016] The present invention provides a pedal for bikes, which is less expensive to make than comparable conventional bicycle pedals.

[017] The present invention provides a pedal for bikes, which has a lower stack height.

[018] The present invention provides a pedal for bikes, which is stronger, which is easier to rebuild, which is more durable, which weighs less and which does not affect Q-factor adversely.

[019] The foregoing and other advantages are attained, according to the present invention, by a pedal with a shaft fixed to the pedal body instead of a spindle that turns relative to the pedal body. A sealed cartridge ball bearing is mounted to the end of a crank arm. The shaft does not turn relative to the pedal body. The pedal shaft rotates relative to the crank arm instead. The shaft is fitted through the sealed cartridge ball bearing of the crank arm and secured in position. The pedal does not require bearings or bushings or seals as with prior art pedals, because the shaft rotates within the sealed cartridge bearing held within the crank arm. The shaft and pedal body can be combined to create an even simpler pedal. This system has a number of advantages over the prior art.

[020] This pedal and crank system allows the pedal to be dramatically simplified. For example, the currently simplest clipless pedal has 13 components total and four sided entry. It also has three dynamic seals and one static seal to keep out contamination from the bearing and bushing. By using this new technology for this pedal, the number of components is reduced to seven parts for the pedal and two extra parts for the crank, and only two dynamic seals (on the sealed cartridge bearing). This contributes to a more durable and reliable pedal, as well as rendering it easier to manufacture. Most other prior art clipless pedals have far more components than 13 and would have an even greater reduction in components by using this new technology. Standard pedals (non-clipless) are similarly simplified using this novel concept.

[021] The pedal and crank system of the present invention has applications from the very inexpensive up through the most expensive and high performance bicycles. For inexpensive bicycles, the pedal can be made with fewer parts. In its most extreme, the pedal could be made in only two parts: a combination shaft/pedal body and a screw (to secure the shaft to the bearing). The crank would have two more parts than a typical crank arm (bearing, retainer), so the total pedal and crank system has only four total components compared to other basic prior art pedals containing from 10 to 30 components.

[022] This pedal and crank system has a fixed shaft that can be stronger and lighter than a spindle. With many prior art clipless pedal designs, the spindle must taper faster than preferred in order to make room for the clipping mechanism and the bearings, bushings, and seals. A fixed shaft, on the other hand, can be designed with more freedom from constraints because there is no need to fit bearings and bushings within the clipping mechanism. In fact, in many cases, the fixed shaft can be made completely hollow to maximize stiffness to weight ratio. The over-all weight of the pedal can decrease 10 to 30% or even more, depending on the pedal design. For example, the weight of the prior art four sided clipless pedal given in the above example would decrease about 20 grams per pedal for an all steel version, which is about 15%. In competitive bicycling, this is an especially large amount.

[023] Sealed cartridge bearings are made in high volume for numerous industrial and consumer applications, and the cost is relatively low and the reliability extremely high. Sealed cartridge ball bearings have high quality seals that can seal out contamination even in the harsh conditions that some bicyclists put their bicycles through. Preferably, a sealed cartridge ball bearing such as a deep groove ball bearing is used at the end of the crank arm in order to provide adequate axial and radial loading. However, there are many other types of bearings that also work well.

[024] For very inexpensive bicycles, it is possible to use non-sealed cartridge bearings, or bushings, in order to save cost. Typically, very inexpensive prior art bicycles have pedals without any seals to protect the bearings. However, for durability reasons, it is preferred to use sealed cartridge bearings, if costs allow.

[025] The pedal and crank system of the present invention is much easier to rebuild than prior art pedals. The rebuild kit could be as little as two new sealed cartridge ball bearings. Rebuilding would include removing the screw to remove the pedal, removing the retainer, and removing the sealed cartridge ball bearing. Reassembly would be the reverse of disassembly. A complete rebuild would take a person with average mechanical skills less than five minutes to rebuild a pair of pedals. Prior art pedals are either not rebuildable, or require a much more complicated procedure, and more time.

[026] The pedal and crank system of the present invention allows the stack height to be reduced because in prior art pedals, the bearings and bushings necessarily increase the stack height. By removing the bearings and bushings from within the pedal body, the stack height can be reduced. Conversely, the pedal height can remain the same and instead be strengthened.

[027] This pedal and crank system does not affect Q-factor. Pedal makers will still have the freedom to move the rider's foot as close to the crank arm as desired, as with most prior art pedals.

BRIEF DESCRIPTION OF THE DRAWINGS

[028] The aforementioned objects and advantages of the present invention, as well as additional objects and advantages thereof will be more fully understood hereinafter, as a result of a detailed description of preferred embodiments thereof, when taken in conjunction with the following drawings in which:

[029] FIG. 1 is a perspective view of a prior art pedal;

[030] FIG. 2 is an exploded perspective view of a prior art crank arm and clipless pedal shown in Fig. 1;

[031] FIG. 3 is a perspective view of a crank arm assembly in accordance with one preferred embodiment of the present invention;

[032] FIG. 4 is a perspective view of a clipless pedal assembly in accordance with the preferred embodiment;

[033] FIG. 5 is an exploded perspective view of the novel crank arm and clipless pedal shown in Figs. 3 and 4;

[034] FIG. 6 is a perspective view of a basic pedal in accordance with a second preferred embodiment of the invention;

[035] FIG. 7 is a perspective view of the assembled crank arm and pedal shown in Fig. 5;

[036] FIG. 8 is a side view of the assembled crank arm and pedal shown in Fig. 7;

[037] FIG. 9 is a cross sectional view of the pedal and partial cross sectional view of the crank shown in Fig. 8;

[038] FIG. 10 is an exploded perspective view of an alternative embodiment for securing a cartridge bearing in the end of a crank arm;

[039] FIG. 11 is a perspective view of the partial crank arm assembly shown in Fig. 10;

[040] FIG. 12 is an exploded perspective view of another alternative embodiment for securing a cartridge bearing in the end of a crank arm;

[041] FIG. 13 is a perspective view of the partial crank arm assembly shown in Fig. 12;

[042] FIG. 14 is an exploded perspective view of still another alternative embodiment for securing a cartridge bearing in the end of a crank arm;

[043] FIG. 15 is a perspective view of the partial crank arm assembly shown in Fig. 14;

[044] The description herein refers to reference numerals in the accompanying drawings and these reference numerals refer to the parts therein having the following definitions:

<u>REFERENCE NUMERALS IN DRAWINGS</u>

10	clipless bicycle pedal	20	crank arm assembly
30	crank arm	32	spline
40	sealed cartridge ball bearing	42	hole
50	thread ring	60	fixed shaft
62	hole	64	boss
80	wing	90	body
100	sleeve	110	screw
120	spring	130	screw
140	prior art clipless bicycle pedal	150	seal
155	seal	160	seal
165	seal	180	body

190	cartridge ball bearing	200	bushing
210	spindle	220	prior art crank arm
230	crank arm	232	hole
240	retainer ring	250	crank arm
252	hole	260	screw
270	crank arm	272	hole
280	screw	290	pedal
300	body	302	body platform
304	fixed shaft		

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

[045] FIG. 1 shows a relatively simple prior art clipless pedal **140**.

[046] FIG. 2 shows the components of the relatively simple prior art clipless pedal **140** shown in FIG 1. There is one static seal **150** and there are three dynamic seals **155**, **160**, and **165** necessary to keep contamination away from internal cartridge bearing **190** and bushing **200**. Pedal **140** has only 13 components, whereas most clipless pedals have between 15 and 50 components. After spindle **210** is screwed to crank arm **220**, body **180** turns in relation to crank arm **220**. In other words, after assembly, spindle **210** is effectively fixed to crank arm **220**, and body **180** rotates freely on bearing **190** and bushing **200**. Prior art pedals, all have some form of body that rotates around a spindle. A fixed shaft in a pedal is believed to be unique.

[047] The present invention may be understood by referring to FIGs. 3-15. By way of example, referring first to FIGS. 3 to 9, it will be seen that the foregoing and other objects are attained, according to the present invention by a pedal **10** with a shaft **60** fixed to the pedal body **90** instead of a spindle that turns relative to the pedal body. A crank arm assembly **20** is comprised of a sealed cartridge ball bearing **40** mounted to the end of a crank arm **30** and held in position by a retainer **50**. The shaft **60** does not turn relative to the pedal body **90**. The pedal shaft **60** rotates relative to the crank arm **20** instead. The shaft **60** has a boss **64** that is fitted through hole **42** of sealed cartridge ball bearing **40** and a screw **130** secures shaft **60** in position. Pedal shaft **60** rotates relative to crank arm **20** instead of relative to pedal body **90**. Pedal **10** does not require bearings or bushings or seals as with prior art pedals, because the shaft rotates within the sealed cartridge bearing **40** held within crank arm **20**. The shaft and pedal body can be combined to create an even simpler pedal **290** shown in FIG. 6. This system has a number of advantages over the prior art.

[048] FIG. 3 shows a crank **20** comprised of a crank arm **30**, a sealed cartridge ball bearing **40**, and a thread ring **50**. Bearing **40** has a hole **42**. Crank arm **30** has a spline **32** for attachment to a typical bottom bracket (not shown), as is well known in the prior art. A screw and washer (not shown) secure the crank arm **30** to the bottom bracket, as is well known in the prior art. Alternatively, the spline could be of square cross-section or other shapes that key to the bottom bracket spindle, or crank arm **30** could have a bottom bracket spindle as part of the crank arm **30** making it an "integrated" crank, as is well known in the prior art. Integrating a bearing into the end of a crank arm is believed to be unique.

[049] FIG. 4 shows a clipless pedal **10** with a fixed shaft **60** instead of a spindle. Fixed shaft **60** connects to crank arm assembly **20** by fitting boss **64** into hole **42** of crank arm **30**. Body **90** does not turn in relation to fixed shaft **60**, because fixed shaft **60** can turn in relation to crank arm **30**. Pedal **10** is secured to crank arm assembly **20** by a screw **130**.

[050] FIG. 5 shows the components of crank arm assembly **20** shown in Fig. 3, and clipless pedal **10** shown in Fig. 4. Crank arm assembly **20** is comprised of a crank arm **30**, a sealed cartridge ball bearing **40**, and a thread ring **50**. Pedal **10** is comprised of a fixed shaft **60**, a wing **80**, a body **90**, a sleeve **100**, a screw **110**, a spring **120**, and a screw **130**. Note that pedal **10** has only seven components and crank arm assembly **20** has only two components more than typical crank arms. Therefore, effectively, this novel system has only nine total components compared to prior art pedal **140**. Pedal **10** retains all the advantages that pedal **140** has over other clipless pedals, yet compared to pedal **140** which has 13 components, pedal **10** weighs less, is more simple and less expensive to manufacture, has a stronger and stiffer structure, is easier and faster to rebuild, is more durable, and has better contamination protection.

[051] FIG. 6 shows a basic pedal **290**, which, because of the present invention, is more simple than prior art basic pedals. Pedal **290** is comprised of only two components: a pedal body **300** and a screw **130**. Pedal body **300** is a one piece construction of a body platform **302** and a shaft **304**. Shaft **304** fits into hole **42** of bearing **40** of crank arm assembly **20**, and is held in position by screw **130**. Pedal body **300** could be made by various manufacturing

methods including lost wax casting, forging, die casting, and stamping. When installed, body **300** turns in relation to crank arm **30**. Note that pedal **290** has only two components and crank arm assembly **20** has only two components more than typical crank arms. Therefore, effectively, this novel system has only four total components compared to other basic prior art pedals containing from 10 to 30 components. Pedal **290** retains all the advantages basic prior art pedals, yet compared to prior art pedals, pedal **290** weighs less, is more simple and less expensive to manufacture, has a stronger and stiffer structure, is easier and faster to rebuild, is more durable, has better contamination protection, and has a lower stack height.

[052] FIGs. 7 and 8 show pedal **10** assembled to crank arm assembly **20**.

[053] FIG. 9 shows a cross section of pedal **10** and crank arm assembly **20** shown in Fig. 8. Thread ring **50** secures sealed cartridge ball bearing **40** to crank arm **30**. Screw **130** secures fixed shaft **60** to bearing **40**. Spring **120** and wing **80** are placed within body **90** and then slipped over fixed shaft **60**. Then sleeve **100** is slipped over shaft **60** and secured by screw **110**. Rebuilding the system would only require removing pedal **10** by removing screw **130**, then removing thread ring **50**, replacing bearing **40**, and re-installing thread ring **50**. Finally, pedal **10** is re-installed by tightening screw **130**.

[054] FIG. 10 shows an alternative method for securing a sealed cartridge ball bearing 40 in a crank arm. Bearing 40 is press fit into hole 232 of crank arm 230, and then a retainer ring 240 is snapped into position.

[055] FIG. 11 shows the assembled components shown in FIG. 10.

[056] FIG. 12 shows an alternative method for securing a sealed cartridge ball bearing 40 in a crank arm. Bearing 40 is fit into hole 252 of crank arm 250, and then a screw 260 is tightened to clamp bearing 40 into position.

[057] FIG. 13 shows the assembled components shown in FIG. 12.

[058] FIG. 14 shows an alternative method for securing a sealed cartridge ball bearing 40 in a crank arm. Bearing 40 is press fit into hole 272 of crank arm 270, and then a screw 280 is tightened to clamp bearing 40 into position.

[059] FIG. 15 shows the assembled components shown in FIG. 14.

OTHER EMBODIMENTS

[060] Those skilled in the art will readily perceive other embodiments. For example, the sealed cartridge ball bearing 40 could be made without seals, or with pins instead of balls, or with tapered pins instead of balls, or with a double row of balls, or as a bushing. Four methods to secure the bearing 40 to the crank arm have already been described, but there are many other ways to achieve this. For example, the bearing 40 could be simply press fit into the crank arm without the need for a secondary fastener. The bearing 40 could have a thread machined into the outer diameter so that it could be directly threaded into the crank arm. The bearing 40 could be bonded to the crank arm. The crank arm could have a race machined into it, and then ball bearings could be added along with another race.

[061] The basic pedal described has only two components. However, it may be even less expensive to manufacture if the body were made from three pieces: A fixed shaft, a body, and a screw to secure the body to the shaft. In that way, the fixed shaft could be made of a material such as steel, while the body is made using a very inexpensive material and process such as injection molded polypropylene. The fixed shaft could have a flat machined into it so that the shaft would be keyed to the body, because the shaft does not need to turn in relation to the body. The injection molded body could be co-molded directly to the fixed shaft, so that a screw is not necessary to secure the body to the shaft. This embodiment, while not quite as simple as the preferred basic pedal embodiment described, is still much more simple and costs less than prior art basic pedals, and has many of the other advantages previously described.

[062] Almost all pedals on the market today could be simplified and improved by using the teaching disclosed herein. For example, a typical prior art clipless pedal has a clipping mechanism consisting of latches and springs and screws, all attached to a body. The body has a bore into which bearings and seals fit. There is a spindle that fits into the bearings and seals and is secured to the body by a fastener. By using the teaching disclosed herein, all the seals and bearings are eliminated within the body, the spindle (now a fixed shaft) can either be enlarged (and preferably hollowed out) and keyed to the body, or the body can be decreased in thickness (reducing stack height) and keyed to the shaft. The new pedal will have fewer parts, and probably weigh less, cost less, have better contamination protection, be stronger and stiffer, easier to rebuild, more durable, and possibly have a decreased stack height. Any one of these advantages is significant. Combined, these advantages have a profound effect on the bicycle art.

[063] Body 90 of the preferred embodiment has been described as being fixed in relation to shaft 60. For ease of manufacturing, in the preferred embodiment the body is not keyed to the shaft and could, in theory, occasionally rotate slightly. This rotation is not necessary for function. Shaft 60 will have less resistance to turn within bearing 40 than body 90 to turn around shaft 60. Body 90 could easily be press fit or otherwise attached to shaft 60, but this is not necessary for this particular design, and would only increase assembly cost. For other embodiments, it may be desirable to key the shaft to the body to ensure no relative rotation between the shaft and the body.

[064] It will thus be evident that there are many additional embodiments which are not illustrated above but which are clearly within the scope and spirit of the present invention. The above description and drawings are therefore intended to be exemplary only and the scope of the invention is to be limited solely by the appended claims and their equivalents.

[065] We claim: